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PROCEEDINGS.

Eight hundred and forty-third Meeting.

May 26, 1891. — ANNUAL MEETING.

The PRESIDENT in the chair.

The death of D. Cecilio Pujazon, Director of the San Fernando Observatory, was announced ; also, the death of Carl Wilhelm von Naegeli, of Munich, and of Carl Johann Maximowicz, of St. Petersburg, Foreign Honorary Members.

The Corresponding Secretary read the annual report of the Council.

The Treasurer and the Librarian presented their annual reports.

The following report was presented : —

Report of the Rumford Committee.

The Committee have held various meetings during the year with reference to the selection of a suitable candidate for the Rumford Medals. They respectfully submit that, in their opinion, the work of Professor E. C. Pickering on the photometry of the stars, and his work upon Stellar Spectra, fully justify the award to him of the Rumford Medals. By his invention of the meridian photometer he has succeeded in bringing order out of the chaos of photometric measurements hitherto made, by referring the photometric measures of all other stars to that of the Pole-star, and thus furnishing an estimate of the change of brightness of the stars with reference to the standard Pole-star. Estimates of the brightness of this star are also made, so that the photometry of the stars has been put upon a basis never before attained.

In his work upon the Draper memorial, Professor Pickering, adopting the method of Fraunhofer, and greatly enlarging the prisms and objectives employed by the latter, has succeeded in obtaining Stellar

Spectra which are comparable in size to the spectrum of the Sun as it was known to Fraunhofer. The method of the latter consisted in placing a prism of small refracting angle directly in front of the objective of the telescope, and in dispensing with the collimator. A cylindrical lens was employed to spread out the more or less linear spectra thus obtained. Fraunhofer's objective was about four inches in diameter, and the prism was a small one, suitable for this aperture. Professor Pickering employed a lens of eight inches in aperture, and a prism eight inches square, with a refracting angle of thirteen degrees. In some cases, three and four prisms were employed. The spectra were enlarged by means of a cylindrical lens, and also by giving the negative a motion in the direction of the lines upon the negative.

Professor Pickering has also employed spectrum analysis to the determination of the motions of the components of variable stars. He has discovered a large number of nebulae and stars with singular spectra. A catalogue of stars with various types of spectra is now under way. The first volume of this catalogue has already been published. This work on stellar spectra is greatly in advance of anything else on this subject which has been done, and is worthy, in the opinion of the committee, of the award of the Rumford Medals.

For the Committee,

J. LOVERING, *Chairman.*

This report was accepted by the Academy, and it was

Voted, That the Rumford Medal be awarded to Professor Edward C. Pickering.

On the motion of Professor Trowbridge, it was

Voted, To appropriate from the income of the Rumford Fund one hundred dollars (\$100) to Professor E. H. Hall for an investigation of the conduction of heat in the walls of the cylinder of the steam-engine, and two hundred and fifty dollars (\$250) to Professor B. O. Peirce for an investigation of the conduction of heat in the interior of solid bodies.

The following appropriations from the general fund were voted : —

For publications	\$1,500
For the library	1,200
For the expenses of meetings . . .	200

On the motion of the Treasurer, it was

Voted, That the annual assessment for the ensuing year be five dollars.

The following gentlemen were elected members of the Academy:—

Henry Taber, of Worcester, to be a Resident Fellow in Class I., Section 1.

Henry Marion Howe, of Boston, to be a Resident Fellow in Class I., Section 3.

Louis Cabot, of Brookline, to be a Resident Fellow in Class II., Section 3.

Josiah Royce, of Cambridge, to be a Resident Fellow in Class III., Section 1.

Abner Cheney Goodell, Jr., of Salem, to be a Resident Fellow in Class III., Section 3.

Thomas Corwin Mendenhall, of Washington, to be an Associate Fellow in Class I., Section 2, in place of the late John H. C. Coffin.

George Park Fisher, of New Haven, to be an Associate Fellow in Class III., Section 3, in place of the late George Bancroft.

The annual election resulted in the choice of the following officers:—

JOSEPH LOVERING, *President*.

ANDREW P. PEABODY, *Vice-President*.

JOSIAH P. COOKE, *Corresponding Secretary*.

WILLIAM WATSON, *Recording Secretary*.

ELIOT C. CLARKE, *Treasurer*.

HENRY W. HAYNES, *Librarian*.

Council.

ARTHUR SEARLE,	} of Class I.
WILLIAM E. STORY,	
CHARLES R. CROSS,	

SAMUEL H. SCUDDER,	} of Class II.
DAVID W. CHEEVER,	
SERENO WATSON,	

EDWARD J. LOWELL,
 MARTIN BRIMMER,
 LUCIEN CARR, } of Class III.

Rumford Committee.

WOLCOTT GIBBS, JOSEPH LOVERING,
 JOHN TROWBRIDGE, GEORGE B. CLARK,
 JOSIAH P. COOKE, ERASMUS D. LEAVITT,
 BENJAMIN O. PEIRCE.

Member of the Committee of Finance.

AUGUSTUS LOWELL.

The President made appointments as follows: —

Committee of Publication.

JOSIAH P. COOKE, WILLIAM G. FARLOW,
 JOHN C. ROPES.

Committee on the Library.

HENRY P. BOWDITCH, AMOS E. DOLBEAR,
 EDWARD J. LOWELL.

Auditing Committee.

HENRY G. DENNY, AUGUSTUS LOWELL.

The following papers were presented by title: —

On a Kephir-like Yeast found in the United States. By Charles L. Mix.

On the Matrical Equation $\phi\Omega = \Omega\phi$. By Henry Taber.

On the Movement of Electricity in Iron. By John Trowbridge and W. C. Sabine.

Eight hundred and forty-fourth Meeting.

June 10, 1891. — MONTHLY MEETING.

The PRESIDENT in the chair.

A biographical notice of Henry Jacob Bigelow, by Dr. Oliver W. Holmes, was read.

The following papers were presented by title: —

Notes on Fungi. By William G. Farlow.

Concerning the Life-History of *Saccorhiza dermatodea* (De la Pyl.) J. Ag. By William A. Setchell.

A Revision of the Atomic Weight of Copper. Fourth Paper. By Theodore W. Richards.

On some Considerations regarding Helmholtz's Theory of Consonance. By Charles R. Cross and Harry M. Goodwin.

On the Minimum Number of Vibrations necessary to determine Pitch. By Charles R. Cross and Margaret E. Maltby.

Eight hundred and forty-fifth Meeting.

October 14, 1891. — STATED MEETING.

The PRESIDENT in the chair.

The following letters were read by the Corresponding Secretary: from Louis Cabot, accepting Fellowship in the Academy; from the Tacoma Academy of Science, announcing its formation, and asking for the publications of the American Academy; from the Royal Academy of Sciences of Lisbon, announcing the death of its Secretary, José Maria Latino Coelho; from George Walter Hael, claiming that the clefts found upon the earth and the moon are due to the action of meteors; from the friends of Wilhelm Weber, announcing his death; from Eduard Marchal, announcing his election as Permanent Secretary of the Royal Academy of Belgium; from J. Veniezra, announcing his appointment as Director of the Marine Observatory of San Fernando; from the Royal Society of New South Wales, enclosing a programme of subjects for medals and money prizes to be obtained by competition; and from W. K. Warren, executor of the estate of Cyrus M. Warren, Fellow of the Academy, announcing a bequest to the Academy.

On motion of the Treasurer, the following vote was passed.

Whereas, The will of our late honored Associate, Cyrus M. Warren, contains the following provisions: —

"VII. I give and bequeath to the American Academy of Arts and Sciences of Boston one hundred shares of the capital stock of the Warren-Scharf Asphalt Paving Company, the proceeds, dividends, and income thereof to be applied by the said Academy, its trustees or directors, in their discretion, for the encouragement and advancement of research in the science or field of chemistry.

"VIII. I give and bequeath to said American Academy of Arts and Sciences fifty shares of the capital stock of the said Warren-Scharf Asphalt Paving Company, the proceeds thereof to be applied to or towards a building fund, for the purpose of erecting a building for the use of the library of said Academy, and for holding the meetings of said Academy; the same to be used in erecting such a structure when, in the opinion of the directors or trustees of said corporation, a sum sufficient shall be realized to justify such erection."

Voted, That the American Academy of Arts and Sciences accepts said bequests, and directs its Treasurer to keep the funds arising from them distinct, so that they may be applied in accordance with the conditions recited in the will.

The following gentlemen were elected members of the Academy:—

Warren Upham, of Somerville, to be a Resident Fellow in Class II., Section 1.

William Brewster, of Cambridge, to be a Resident Fellow in Class II., Section 3.

Edward Gardiner Gardiner, of Boston, to be a Resident Fellow in Class II., Section 3.

Samuel Jason Mixter, of Boston, to be a Resident Fellow in Class II., Section 4.

On motion of Dr. Williams, it was

Voted, To amend Standing Vote 10 by substituting "may" for "shall."

As amended, the standing vote reads as follows:—

"10. A meeting for receiving and discussing scientific communications may be held on the second Wednesday of each month not appointed for stated meetings, excepting July, August, and September."

Eight hundred and forty-sixth Meeting.

January 13, 1892. — STATED MEETING.

The Academy met at the house of the Hon. Martin Brimmer.

The VICE-PRESIDENT in the chair.

On the motion of the Recording Secretary, it was

Voted, To meet on adjournment on the second Wednesday in February next.

The chairman, in a brief address, announced that the Rumford Premium had been awarded to Professor Edward C. Pickering for his work on the photometry of the stars and upon stellar spectra.

Professor Pickering, in response, gave an account of the photographic work under his direction at the various stations in North and South America.

Dr. William Everett announced the death, on the 19th of December, 1891, of Sir George Biddell Airy, late Astronomer Royal, at Greenwich, elected a Foreign Honorary Member on the 25th of January, 1832, and since the death of Robert Treat Paine, in 1885, the senior member of the Academy.

Dr. William W. Jacques presented a paper entitled, "What Electricity is." This paper was illustrated by a new piece of apparatus invented by Dr. Jacques.

In the discussion which followed, Professor Cross, Judge Holmes, and Major Livermore participated.

Eight hundred and forty-seventh Meeting.

February 10, 1892. — ADJOURNED STATED MEETING.

The VICE-PRESIDENT in the chair.

The death on the 18th of January of Joseph Lovering, President of the Academy, was announced, and the meeting was devoted to a commemoration of his life and services.

The Vice-President, Rev. Andrew P. Peabody, opened the proceedings with the following words : —

We are convened this evening to express our sorrow for the death of our late President, and to offer our tribute to his memory. While it belongs to me officially to lead in the proceedings of the meeting, there is a certain fitness in my doing so, as my knowledge of Mr. Lovering antedated that of any one else here present. Most of you were his pupils ; he was my pupil. In his Senior year in college his class recited in Astronomy to me. My only remembrance of him in the class-room is that he was one of the three or four on whom I relied to do credit to the class and their teacher in the oral examination at the end of the term. But he was brought into closer relation with me in another department. With three or four of his classmates he studied Hebrew with me for that entire year, and for that purpose spent three hours a week in my room. I then learned to admire the diligence, promptness, and accuracy which have marked his life-work ever since. He became, so far as was possible in a single year, a proficient in that language, which many who ought to be conversant with it find so hard to learn and so easy to forget.

Immediately after graduating he entered the Divinity School, and had nearly completed his preparation for the ministry when, in consequence of Professor Farrar's illness, he was requested to continue and complete a course of lectures in the department of Physics. Professor Farrar became a chronic invalid, and the place which Mr. Lovering first filled in an emergency he held, as Tutor and Professor, for fifty-three years. It was no small thing to succeed Professor Farrar. Those who heard his lectures, of whom few survive, were wont to speak of him as the most eloquent of men. Yet from the very first, both in Physics and in Astronomy, Mr. Lovering won a reputation that gave him a foremost rank as a scientific lecturer, which remained his when the grandchildren of his early classes sat under the wordfall still fresh and bright, because both old and ever new.

I speak here not only from abundant testimony, but from my own hearing. While the Lyceum was still an educational institution and enlisted the best men in its service, I had the pleasure of listening to several of his astronomical lectures, and at the same time of receiving him as my guest. I then could recognize at once the thoroughness of his scientific scholarship, his clearness of apprehension, his unsurpassed teaching power, and his gifts of style and manner, which could not but secure for him a marvellously strong hold on an intelligent audience.

Since my return to Cambridge I have been intimately associated with him, and these years have given me constant, and, were there

room for growth, growing experience of traits of mind, heart, and character which have won my profound respect and sincere affection.

In the sixty years for which I have known him, there has been nothing in deed or word to break the record of a life pure, true, faithful, and kind. Rigidly conscientious in the least things as in the greatest, he has shown the worth and power of the religion whose worship and ordinances he has held in constant and sacred observance.

So young seemed he for his years, we looked not that he should be taken from us thus early. With bodily strength but slightly impaired, he retained his clearness, vigor, and activity of mind to the last. We are thankful that he passed away while we can feel his loss and mourn his departure, — that he was spared the prolonged decline and infirmity which we who are growing old most of all dread and deprecate. His life was beautifully rounded; its work done, and well done; and he was happy in the timeliness of his death no less than in the gratitude and honor which grew with his years, crowned his old age, and insure for him a precious and blessed memory.

With the approval of the Council, I offer for the Academy the following resolutions: —

Resolved, That, in the death of our late President, the Academy has lost a member whose reputation and whose many years of loyal service have contributed largely to its honor and prosperity, and a presiding officer whose assiduity, courtesy, and kindness have won for him from all his associates the most cordial and grateful regard.

Resolved, That we hold in precious remembrance his high scientific attainments, his eminent ability and success as a teacher, his place among the foremost in the reverence and love of the graduates of Harvard University, his pure and elevated character, and the worth of his example and influence as a Christian gentleman and scholar to the successive classes of students who, for more than half a century, passed under his instruction and discipline.

Resolved, That a copy of these resolutions be sent to his family, with the expression of our sincere sympathy with them in their bereavement.

The resolutions offered by the Vice-President were seconded by President Eliot of Harvard University: —

Professor Lovering's life seems to me to be better characterized by the word fidelity than by any other. He was just as faithful in the least things as in the greatest. Whatever work he undertook, he did thoroughly and steadily, although it might be uninteresting, mechanical, or really unsuitable for one of his station and powers. He heard

recitations in Lardner's *Natural Philosophy* for many years of his life, and for a part of the time he heard each lesson three times over, — the class in *Physics* being divided into three sections. The book was very elementary, and far from interesting, and the class was boyish in attainments and in spirit; but year after year he performed that humble function with an absolute fidelity. For many years he gave illustrated lectures on all the main subjects in *Physics*, — generally two lectures a week throughout the academic year; and he himself made all the preparation for the experiments, with no assistance except that of the bell-ringer, who came in to help him move heavy pieces of apparatus or to work the air-pump. With perfect patience he performed weekly for years, without any assistant, this great amount of manual labor in connection with his lectures; and, as his lectures were repeated year after year during more than forty years, the weariness of repetition was added to the physical fatigue.

For twelve years, from 1857 to 1869, he was Regent of the College. That officer kept the records of absences and of the marks received by the students at their recitations. With his own hand Professor Lovering entered the absences and the marks in the record books, kept watch on the absences of every student in College, considered excuses, and reported delinquents to the Faculty week by week. The Regent exercised discretion and needed good judgment; but far the greater part of his time was devoted to accurate, patient, clerical labor. He was in his office three days of the week for two hours each day, and his compensation was five hundred dollars a year. I mention these details because they perfectly illustrate a quality in Professor Lovering which the men of a younger generation may well imitate, — a capacity for assiduous routine labor. Every great scholarly achievement is accomplished by just such faithful industry. An inspiration is a momentary flash; a high purpose has an instant of formation; but inspiration and purpose have to be wrought out through years of unremitting labor.

I have always admired in Professor Lovering the mixture of conservatism with openness of mind. His natural conservatism was modified by a true scientific candor. Change for its own sake he never desired; but he could be convinced by experience that a given change was an improvement. He held to the opinions and practices which he had adopted before he was forty years old; but his mind was also open to new projects. When the rapid expansion of Harvard University began in 1866, just after the close of the Civil War, Professor Lovering was already fifty-three years old and had been

thirty years in the College service. When I was elected President he was fifty-six, — a time of life at which many men become impatient of changes which seriously affect their own habits of work. Yet Professor Lovering welcomed the project of moving the entire physical establishment from its narrow quarters in University Hall to larger rooms in Harvard Hall. He personally arranged the lower floor of Harvard Hall to receive the Department of Physics, and was highly content with the new accommodations of the department when the transfer was completed, in 1870. But the department grew apace, and the great gift of Mr. T. Jefferson Coolidge for the construction of a new physical laboratory made it possible to provide the department with larger quarters still, and opened the way to a great increase both of the teaching and of the investigation which it carried on. At the age of seventy-one Professor Lovering entered heartily into this large undertaking, brought to it a flexible and fertile mind, moved again from Harvard Hall to the Jefferson Physical Laboratory, and was glad to be appointed the first Director of that ample establishment.

He had been all his life an advocate of a single prescribed curriculum for Harvard College, whereby every student should pursue the same subjects; but after he was established as Director of the Jefferson Physical Laboratory, and had at his disposition an admirable lecture-room and a much enlarged cabinet of apparatus, I asked him one day if he would give some lectures to the Freshmen on general physics; for I wanted the Freshmen to have the advantage of his singular clearness of exposition. He asked if the Freshmen were not required to attend those lectures, — a question which then could only be answered in the affirmative. Whereupon he refused to give the lectures, saying that he would never again lecture in a required course, or to an audience whose attendance was required.

As I look back upon his life, it seems to me that it was to an extraordinary degree independent and self-contained. While entirely devoted to Harvard University as an institution, and inclined by temperament to support the constituted authorities of the University, he was nevertheless peculiarly independent in his own professorship, and had been ever since he was first elected to his chair, at the age of twenty-five. He served the College under seven Presidents, and I am sure that they all found him, as I did, considerate, firm but never factious in opposition, and loyal in support. His religious opinions were the quintessence of independence, and they were held with a firmness which no influence, however near and strong, could shake.

In the conduct of his household he would owe no man anything. Throughout a long life he was frugal and skilful in keeping his savings. His wants being simple, he thus earned the satisfaction of feeling during the last twenty years of his life that he was fairly independent in money matters, — a great satisfaction to a reserved and self-respecting man.

Faithful, constant, candid, independent, — these seem to me some of the high qualities of Joseph Lovering.

I ask leave, Mr. President, to second the resolutions you have offered.

After President Eliot, the Corresponding Secretary, Professor Josiah P. Cooke, addressed the Academy : —

I have been asked to speak of our late President as a teacher ; and although I could wish that the duty had fallen to one who could portray more forcibly his remarkable ability as a college and public lecturer, I feel that there is a certain fitness in the assignment, since I have held intimate relations with him, first as pupil and afterwards as associate, for more than fifty years. My acquaintance with him began much earlier than his with me ; for, when quite a youth, I was a constant attendant at his earlier lectures before the then recently established Lowell Institute, which were at that time given in the Odeon on Federal Street, near my father's home. From those lectures, continued several years in succession, I gained my earliest conceptions of Mechanics, Electricity, and Astronomy. I can remember many of the experimental illustrations as clearly as if the lectures had been given yesterday, and it is a striking evidence of the lecturer's definiteness of statement and aptness of illustration that a young boy should have been interested and instructed by lectures on subjects so abstruse. These lectures were given on Wednesday and Saturday afternoons, when there was a half holiday at school ; and I remember they were well attended, although they were repetitions of lectures on the previous Tuesday and Friday evenings. At this time the elder Professor Silliman was charming the Lowell Institute audiences by his brilliant lectures on Chemistry, but Mr. Lovering did not suffer from the comparison ; and if the fascination arising from the fluency and wealth of illustration of the elder man gave the bent to the boy's mind, he never questioned who was the more instructive lecturer.

At this time, from eight to ten years after his graduation from college and three to four years after his appointment as Hollis Professor at Cambridge, Mr. Lovering did not give me the impression of a

young man, and through our long acquaintance he did not seem to age until within the few last years. Of course such an impression largely arises from the constancy of the mutual relations of men growing old together; but after making all allowance for the point of view, I think it will still appear that our colleague, although a very young old man, was a very old young man. As I look back I think this arose very much from the absence of that nervous susceptibility which is such a hindrance to most of us, and greatly increases the friction under which we work. Professor Lovering's imperturbability was notorious with all the graduates of the College during the last half-century. When he lectured he never showed the least emotion, and in the class-room his control of the muscles of his countenance was extraordinary. Not many years after the period I have mentioned, I passed through the regular course in Physics at our College, and I can see the Professor now, sitting like an inquisitor on an elevated chair overlooking the class, with his spectacles over the forehead, with the text-book, to which he never referred, on the desk before him, and directing his questions to one man after another in the clearest but most incisive terms, and in the exact order of the book, without hesitation or failure of memory. Each student was expected to take up the subject where the last left it, and I still wonder at the feats of memory which enabled some of the class to repeat mathematical formulas, even differential equations, without the remotest intelligent knowledge of their meaning. But although it was obvious that the Professor followed every detail and noticed every inaccuracy, yet the most absurd blunders and ridiculous incongruities never elicited a smile, or were any further noticed than by calling up the next man. No direct instruction, not even any elucidation of the book, was ever attempted. We did learn the book so far as it was intelligible to us, but nothing more. We must not, however, judge such exercises by our present standards. This formalism was the fashion in the education of the time, and the all but universal rule in the College.

The dulness of the recitations was, however, at times enlivened by the dry humor for which Professor Lovering was so noted among his friends. An incident which he was fond of telling himself is very characteristic, and recalls vividly those old college days. In the text of Herschel's Astronomy, which was recited verbatim for many years in the well known class-room at the south end of University Hall at Cambridge, there is quite a full description of the seven asteroids known at that time, and then follows a sentence something like this: "Besides these seven, others will probably be discovered." One day

a faithful but formal student gave it, "Besides these, seven others will probably be discovered." The Professor, with his imperturbable fixed gaze, simply asked, "Why seven?" and called the next man. The bull was afterwards several times repeated, and the Professor had the credit of selecting his victims for the purpose; but I have also heard, what is more probable, that the class handed down the joke, and that the repetitions were the result of collusion among themselves.

The number of the asteroids now exceeds three hundred, and this astounding development of Herschel's prediction is only of a piece with what has passed in all departments of physical science. In the middle of the century the question between the undulatory theory of light and Newton's theory of emissions was still open, and in Brewster's Optics, the text-book we studied, the weight of authority was given to the latter theory. So also the different modes of energy were regarded as imponderable fluids, and a no inconsiderable part of the text-book on Electricity was taken up with a discussion of the merits of the then usually received theory of two electric fluids, as compared with Franklin's theory of one. During Mr. Lovering's long life the fundamental conceptions of physics entirely changed, and it was one of his great merits as a teacher that he kept abreast of the times, that he weighed systems impartially, and led his pupils to distinguish clearly between ascertained facts and the systems of science by which the facts are classified.

At the formal recitations I have described Mr. Lovering presided as an officer of the College to enforce a prescribed task. He did not consider that he was there to teach, in any proper sense of the term. He had assigned an excellent book from which it was our duty to learn, and from which we could learn, all of the subject we were expected to know, and it was solely his duty to see that we did our work. This does not seem to us now a very high ideal of a college exercise, although doubtless the lazy men and the dullards did gain an occasional idea from hearing their classmates' recitations. Still, it must be remembered that this was the attitude of teachers in almost all the class-room exercises of the period, and no one could have done the duty assigned to him more faithfully or more impartially than Mr. Lovering.

But if Professor Lovering, with most college teachers of his time, did not feel it incumbent on him to give personal instruction in his recitations, it was very different with his stated lectures. At these he displayed his full intellectual strength, and I look back on them as

in many respects the most profitable part of my college course. He was one of the best lecturers I have ever known, and I have known the greatest masters of my time. He may not have had the imagination of Faraday or the grace of Dumas, but his lectures were instructive in the highest degree. The chief sources of his power are not far to seek. In the first place, he had the great art of bringing his reasoning and his illustrations to the intellectual level of his hearers, without belittling his subject. He was a popular lecturer in the very best sense. He did not commit the common error of seeking to gain attention through trivialities, or of attempting to appear learned by using technical terms; but he sought to raise his audience from their lower plane to his level, and he succeeded to a wonderful extent. Again, he had remarkable clearness of statement, and he gained this in the only way it can be gained, by seeking definiteness of conception. He did not trust to the inspiration of the moment to make a difficulty, however familiar to him, intelligible to others; but he laboriously studied every subject he taught until he had a firm grasp of all the concepts, and then the stream was clear because the spring was clear. Lastly, Mr. Lovering had to a greater degree than I have ever known, the power of looking at physical problems from different sides, and seeing them in all their aspects. This gave him great fertility in illustration, and often enabled him to present a subject from a point of view wholly unexpected even by adepts in the science.

We often say in the laboratory, when troubled by the failures of a faithful student, but unskilful experimenter, that a chemist, like a poet, is born, not made, and the same must be equally true of a physicist; and if we consider only the power of original investigation, there is doubtless much truth in this trite apothegm; but it is not true of many great scientific scholars and teachers, and of this Mr. Lovering's success is a conspicuous example. In college he was one of the first scholars of his class, but although a good mathematician his tastes were linguistic and literary rather than scientific, and he had already entered on the study of Divinity when a chance opening determined his career in life. The opinion has often been expressed that the intuitions and enthusiasm of an original investigator are necessary to make a great scientific teacher, and if by this is meant necessary to direct to the best advantage the studies of those born to the purple, I should agree in the judgment. But, on the other hand, the devious and narrow paths through which the investigator is constantly led in the chase of natural phenomena are apt to give him a very limited view, while the scholar who commands a larger field is better able to

point out to ordinary minds the extent and bearings of the numerous details which it has required very many explorers to bring to light. This was strikingly true of Mr. Lovering. He was not, as he himself would be the first to avow, a born investigator, although, as his successor will doubtless tell you, he did very substantial work as an original student; but he was a great teacher, and I am persuaded that the experiences of his education to which I have referred had an important influence on the result. He came to the study of physics as a ripe literary scholar; and he dwelt on its various fields, with their intricate relations, until he had acquired clear conceptions of the whole ground, and it was thus that he gained the power of presenting all the details with such clearness and force.

So called "original research" is now a fad in education, and we are in danger of overlooking the fact that the scholar and teacher is no less important to the community than the investigator. It is absurd to contend which is the more important member of the body politic. No one has pressed on this community more persistently than myself the importance of scientific investigation, not primarily for the results it may yield, but chiefly as a great influence towards sustaining the higher life of the nation, and yet I feel assured that the explorers would soon lose their reckoning were not there also a class of scholars to co-ordinate their results and supervise their work. It is easy to sneer at popular lectures, and I have as great a contempt as any one for mere glitter and froth; but the lecturer who can raise men to a higher intellectual level confers a benefit on the community which is none the less real because its effects may not be at once apparent.

Faraday was one of the very few men who was at the same time a great teacher and a great investigator. I never was more impressed by any intellectual achievement than by the popular, even juvenile, lectures which I once had the privilege of attending at the Royal Institution in London. And, however great the bequests of knowledge this investigator left to mankind, I greatly doubt whether, when the final account is closed, the greatest contribution of Faraday to human welfare will not be found to be his popular lectures. It has been well said that the greatest discovery of Sir Humphry Davy was Faraday, — a mere bookbinder's apprentice when he was fascinated by Davy's brilliant lectures, — and who can number the intellectual offspring of the still greater teacher? It is the misfortune of a college teacher that the successive classes pass on long before the fruits of his influence have time to mature; but the influence lives, and could we trace the effects of our associate's work I am sure that we should

be satisfied that fifty years of devoted service has not been spent in vain.

A substantial part of Professor Lovering's work as a teacher, which we must not forget, are the numerous popular essays on scientific subjects which he published from time to time in various periodicals. Several of the earlier of these appeared in the "American Almanac," and most of the later in the Proceedings of this Academy, including addresses on the presentation of the Rumford Medal, and biographical notices printed in connection with the Reports of the Council. What is probably a complete list, as it was revised by Professor Lovering himself, may be found in the "Popular Science Monthly" for September, 1889, in connection with a short biographical notice. In these essays, popular only in that they do not assume a specialist's knowledge, are preserved to us the striking characteristics of Professor Lovering's teaching to which I have referred. They are as fresh to-day as when written, and are not only highly interesting as choice examples of popular scientific exposition, but also of permanent value, as exhibiting in a striking manner the changes in the modes of scientific thought during the last half-century. I am anxious that the most suitable of these essays for the purpose should be collected and reproduced in a handsome volume, and in my judgment this would be the most fitting memorial we could prepare of our late honored President.

Professor John Trowbridge, the successor of Professor Lovering as Director of the Jefferson Physical Laboratory in Harvard University, next spoke:—

In due time Professor Lovering's scientific labors will receive attention in a more elaborate way than I can pretend to devote to them to-night. His death is so recent that the time for the critical summing up of the labors of a long life has not been sufficient for a careful presentation to you of the subjects in which he worked, and upon which his reputation as a scientific man will rest. The subjects of Astronomy, Meteorology, Magnetism, and Optics were favorite ones with him. I find in the American Journal of Science a paper on Meteoric Observations made at Cambridge in 1839. This paper marks, I believe, the beginning of his scientific work, and following it were a large number of articles on the subjects I have mentioned. The catalogue of scientific papers published by the Royal Society of England contains between the years 1839 and 1863 the titles of eighteen papers. Among these are the following:—

- On Magnetic Observations made at Harvard University. *Memoirs Am. Acad.*, 1846.
- On Coronæ and Halos. *Proc. Am. Acad.*, 1848.
- On the American Prime Meridian. *American Journal of Science*, 1850.
- New Experiments and Modes of illustrating the Laws of Light and Sound. *Proc. Am. Acad.*, 1852.
- On Motions of Rotation. *Proc. Am. Acad.*, 1852.
- On Donati's Comet. *Proc. Am. Acad.*, 1857.
- Memoir upon the Secular Periodicity of the Aurora Borealis. *Proc. Am. Acad.*, 1857.
- On the Velocity of Light and the Sun's Distance. *Proc. Am. Acad.*, 1862.

This number of papers can be greatly increased by the addition of his scientific essays and addresses. He also did much routine scientific work in connection with the determination of longitude by the Coast Survey, holding a position as Astronomer to the Survey during the administration of Professor Benjamin Peirce.

The subjects of sound and light, and wave motion in general, I have said, were favorite ones with him, and he took great pleasure in adding to the Physical Cabinet apparatus to illustrate these subjects ; so that to-day they form the most complete portion of the apparatus for demonstration which he left to his successors. I remember that he once showed me an apparatus which he had devised for obtaining the velocity of electricity, which combined in an ingenious manner the apparatus in sound with which he was so familiar and certain arrangements of electro-magnets. It is doubtful whether Professor Lovering's contemporaries, who occupied chairs of Natural Philosophy in American colleges can show so large an amount of scientific work as he performed in addition to his college exercises.

After listening to such appreciative words as we have heard from those who have been the life-long friends of Professor Lovering, I feel that my testimonial may seem scant. Those who attended his lectures have a store of remembrances of his wise sayings, of his peculiar humor, which often threw the light of a different philosophy from that which he was professedly elucidating, and which showed that literary tendency which made him capable of giving wise counsel over a wide range of University matters. Strange to say I never heard one of his college lectures, but I knew from conversations with him that he could present a subject with a certain finish and fine deliberation which was the despair of new beginners in the art of demonstration. I have seen him prepare an experiment for a lecture with that patience which Balzac is said to have devoted to his paragraphs, taking every possible care that

the form in which the idea was to be presented should not break down through that spirit of total depravity which sometimes seems to preside over physical experimentation. Professor Lovering, imbued with a philosophy of life which I am inclined to believe was one of his most remarkable attributes, knew full well that this depravity of inanimate objects was the expression of want of patience and thought in the experimenter, and he never hesitated to try an experiment scores of times before its presentation at the lecture table.

All who enjoyed intimate friendship with him must have felt the strength of this fine deliberation and careful conduct toward the forces which shape our physical life. Acting with him on the Rumford Committee, and sometimes on other committees, I have felt that in voting with him I should be safely conservative, and the wisdom which only a long life of great thought can give was apparent in every deliberation.

Professor Lovering belonged to a school of Professors of Physics which is very different from that which is now prevailing in our universities and technical schools; for the laboratory method of instruction is taking the place of the lecture method. It was hinted that he hesitated to change the method which had been a life one with him. I doubt, moreover, whether any one who had reached the age even of fifty, and had never accustomed himself to laboratory work, would be willing to enter upon the arduous and trying work of physical research. This work must be undertaken chiefly by younger men. One could always take one's results to Professor Lovering and have them illuminated by the stores of his knowledge of the history of the subject. Professor Eustis once remarked to me, that I should find Professor Lovering a very sound man in his subject, and I verified this remark frequently. I have spoken of the humor with which he often threw the light of philosophy upon things animate and inanimate. A very egotistical student was once giving his views to us at a seaside resort, and after his departure Professor Lovering remarked that he was "all-sufficient, self-sufficient, and insufficient."

In the course of a lecture he was contrasting the undulatory theory of light with the corpuscular theory, and after stating with a certain judicial manner the objections to the latter theory and leaving it no ground to stand on, he finished it thus, in his slow, deliberative tones: "The reason that the corpuscular theory is no longer advocated is that all its advocates are dead."

Some men are compelled to assert themselves through the whole course of their lives, for the world is not vividly conscious of their

presence in it. Professor Lovering, however, had a marked personality, which did not seem to require self-assertion. He was a marked man in any gathering. Perhaps he gave the impression that he had conquered the world and could smile at its foibles, and one desired to catch the secret of his self-possession, with the expectation of having it told with humor. It seems to me that he resembled certain great philosophers, and might be said to be a follower of Aristotle.

We all remember that his presentation of a subject had a certain old-time stateliness of manner, which was perfect in the days when oratory was much esteemed, and had not become affected by an age of telegrams and telephone communications. I believe that a collection of the essays of Professor Lovering on physical and astronomical subjects would show that discriminating spirit and deliberative wisdom, and that peculiar literary style, which characterized him, and which must leave a permanent remembrance upon the minds of all who knew him.

Still further tributes to the noble character and great worth of our deceased President were made in the following letters.

From Hon. Robert C. Winthrop.

MY DEAR DR. PEABODY, — I regret extremely that age and infirmities will prevent my attending the meeting of the Academy to-morrow evening. It would afford me peculiar satisfaction to be present at the commemoration of our lamented friend, Professor Lovering, and to listen to the tributes proposed for the occasion. His services as President of the Academy constitute but a small part of his claim to consideration. His lifelong loyalty to the cause of science, and his devotion to the University as Professor for more than half a century, entitle him to a most grateful remembrance.

Nor can I forget my association with him, for several years past, as one of the Trustees of the Peabody Museum of American Archæology and Ethnology.

I say nothing of the pleasant relations which I enjoyed with him as a friend, and of the respect which I have always entertained for his character.

Believe me, with renewed regrets that I cannot attend the meeting,

Yours, sincerely,

ROBERT C. WINTHROP.

From Professor W. W. Goodwin, of Harvard University.

MY DEAR DR. PEABODY, — I am very sorry that I cannot attend the meeting of the Academy this evening in memory of Professor Lovering. Of our late President as a man of science I have no right to speak, for I can claim only to be one of the large class of his admirers who viewed his scientific attainments from a respectful distance. But I have known him for more than forty years as a kind friend, and in later years as a genial companion; and by his death I have lost one for whom I felt deep respect and warm affection.

I first knew Mr. Lovering as lecturer and teacher in Harvard College. In 1849, when I first came under his instruction, he was in his best vigor, and his lectures on mechanics, optics, electricity, and magnetism always seemed to me perfect of their kind, and admirably adapted to their purpose, which was to give a general knowledge of physical science to a whole college class, who had no opportunity to study in detail more than a small fraction of the sciences which his lectures covered. It seems to lie beyond the province of our reformed College to give this general view of the physical sciences, or indeed of any of the sciences, to our students; and perhaps we do not always remember that the knowledge which every student had an opportunity to gain from Mr. Lovering's lectures ought still to be brought within the reach of every one at some stage of his education.

In the old College Faculty, as I first knew it in 1856, Professor Lovering was one of the most important and influential members. He was constant in his attendance, and he always had a decided opinion on every question that came up. He often decided a long and wandering debate which had led to nothing, by a few words of plain common sense, or even by a humorous remark into which an argument was condensed. His dry humor was second only to that with which that master of humor, President James Walker, constantly entertained and often convinced the College Faculty. During a great part of the presidencies of Mr. Sparks, Dr. Walker, Mr. Felton, and Dr. Hill, he held the post of Regent, which has since been extended into the less regal but more responsible one of Dean. A comparison of the Regent's office in Mr. Lovering's day, open four hours *a week*, with the present Dean's office, open nine hours *a day*, shows the growth of the College, and also the changed relation of the students to

the officers of administration. In all the affairs of his office, Mr. Lovering was exact and systematic to the last degree. His fixed principles of college government, and his wonderful memory of facts, names, and faces, enabled him to be perfectly consistent in all his dealings with students, and his high standard of justice made it almost certain that no one could be wronged by his decisions. He was, indeed, a model executive officer, and his long administration as Regent did much to establish and confirm the policy of Harvard College for a period of twenty years.

I well remember one of the first occasions when one of the speakers at a College exhibition uttered strong and decided anti-slavery sentiments. One of the older Professors remonstrated to Mr. Lovering, and expressed his surprise that such a passage should have been allowed to be spoken. Mr. Lovering replied, "I have heard the other side of that question here all my life; and I think it is quite time that we heard this side now."

Mr. Lovering's sense of fairness was one of his most marked characteristics. He was also a man of remarkable kindness and sympathy, which often took the form of most efficient action even when he seemed to try to repress its expression in words. His whole personality was, indeed, a most striking one, which impressed every one who met him, while it was fully appreciated only by those who knew him best.

Regretting that I cannot listen to the tributes of respect which will be offered to his memory this evening, I remain ever

Yours, sincerely,

W. W. GOODWIN.

From Mr. Justin Winsor, Librarian of Harvard University.

MY DEAR DR. PEABODY, — Mr. Lovering's failure to be present at a gathering of the Thursday Evening Club in Boston was so unprecedented, that at the meeting which was held during his last illness everybody remarked upon his absence, and it was the first intimation most of us had that he was confined to his house. A fortnight before, at its previous meeting, I had talked with him about his constancy of attendance, and he told me that he had never missed a meeting, and he was among the older members of the Club. Even to the last he was ready to contribute his share to the edification of its members, and he said to me on this last meeting of his attendance, that he was ready to be called upon for a paper, if there should at any time be a gap to be filled.

His enjoyment of the Club was in accordance with such a record of unrivalled faithfulness. He was alive to every phase of intellectual progress, and he found the surprises and novelties offered to the club in such direction, often in advance of more public enunciation, stimulating and enjoyable. He took much gratification in the prompt response which was found among the members of this Club, as well as among the officers and friends of the University, when a testimonial was prepared for him on his retirement from the active duties of his professorship. This movement resulted in a dinner given to him in Boston, which was presided over by the President of the University. Mr. Lovering made a response to the principal toast, in which, with his peculiar humor, he reverted to the events of his long career as a teacher. Dr. Holmes referred to the extent of this career as only comparable in the history of the College to that of Tutor Flynt, and suggested that a duplicate of that old preceptor's silver teapot, which had come down to him by family lines, should make part of the testimonial to Mr. Lovering. This reproduction was carefully made, and Mr. Lovering a little later placed it among his household treasures with evident satisfaction. He was also asked to sit for his portrait, and no sitter could ever have been more faithful to the demands of the artist than he was, — prompt in his place and never tiring. The picture which represents him in his gown as a Professor, sitting full face, was placed in the parlor of his house, ultimately to be transferred to the walls of Memorial Hall.

Yours, sincerely,

JUSTIN WINSOR.

From Professor F. W. Putnam, of the Peabody Museum of American Archaeology and Ethnology.

MY DEAR DR. PEABODY, — On the day assigned for the memorial meeting of the Academy in honor of its late President, Professor Joseph Lovering, I was unexpectedly called out of town, and was thus prevented from uniting with the other members in offering tributes to his memory. Will you therefore permit me to express my appreciation of one whom for over thirty years it has been my privilege to count as a friend.

At the time of my entering the Scientific School, in 1856, Professor Lovering was in the prime of life, and it was my good fortune to attend his lectures. For eight years following, I often had the

pleasure of meeting him, and ever found him genial and ready to give freely of his store of knowledge to an inquiring student.

In 1868-69, we were again intimately associated on the occasion of his trip to Europe, when he delegated to me his position as Permanent Secretary of the American Association for the Advancement of Science, and the editorship of the Chicago and Salem volumes of Proceedings. Again, in 1872, when he was elected President of the Association and resigned the office of Permanent Secretary, it fell to my lot to succeed him in the Secretaryship.

This election to the Presidency was not only a unanimous offering of the Association to a distinguished member, but also a merited recognition of his long and faithful service as its trusted executive officer.

Professor Lovering was the second Permanent Secretary of the Association, and was elected in 1854 as the successor to Professor Baird. He filled the position for nineteen years, and it is well known by the older members that his efforts were unceasing in fostering the objects of the Association. He fully believed in the benefits which would accrue to American science from these annual gatherings of scientific men in different parts of the country. In conversation on this subject, he always expressed his firm belief in the important work of the Association, and the advantage to be derived from this united effort to encourage and develop scientific work by interesting hundreds of cultured men and women in scientific objects, and by stimulating isolated workers to greater exertion. Eminently social and agreeable, he always took great pleasure in these gatherings of kindred spirits, and was an almost constant attendant at the meetings until the last few years of his life. His advice in the Council meetings of the Association, while always somewhat conservative, was nevertheless favorable to progress. His remarks were always earnest, but never hasty or passionate, and were so sure to carry conviction that his views of a subject generally prevailed.

For the third time we were brought into intimate official relations when as President of the Academy, in 1888, Professor Lovering became a Trustee of the Peabody Museum of American Archaeology and Ethnology of Harvard University, as the successor of the late Professor Asa Gray. In this office he was always prompt in attendance at the meetings of the Board and often visited the Museum, in which he was greatly interested.

While Professor Lovering was always serious in his work, and when speaking upon important subjects, yet no one liked better than

he the moderate pleasures of life, or enjoyed sociability with a greater zest.

Thus it has been my fortune to know this friend under many conditions, and through all these years and varied circumstances, official and social, I have never found him lacking in sympathy and readiness to advise and assist in every way in his power, and there has never been a ripple of antagonism to mar our friendship.

Although we deeply regret the loss of this dear friend from our midst, it will always be a pleasure to cherish the memory of his many virtues, his true friendship, his love for his fellow men, and his devotion to science.

Yours, sincerely,

F. W. PUTNAM.

The resolutions were unanimously adopted by the large company of Resident Fellows in attendance at the meeting.

Andrew Howland Russell, of Boston, was elected a Resident Fellow in Class I., Section 4.

Eight hundred and forty-eighth Meeting.

March 9, 1892. — STATED MEETING.

The VICE-PRESIDENT in the chair.

The Corresponding Secretary read letters announcing the death of Sir William Macleay, of Sydney; of John Couch Adams, of Cambridge, England, Foreign Honorary Member; and of the Grand Duke Constantin Nicolayevitch, President of the Imperial Russian Geographical Society. Letters were received from Samuel J. Mixter and Warren Upham, accepting Fellowship in the Academy.

The Vice-President announced the death of Henry Ingersoll Bowditch, George Bassett Clark, Thomas Sterry Hunt, William Raymond Lee, and Sereno Watson, Resident Fellows; and of George Washington Cullum and Noah Porter, Associate Fellows.

On motion of the Corresponding Secretary, it was

Voted, To meet on adjournment on the 13th of April.

On motion of the Recording Secretary, it was

Voted, To amend Standing Vote 9 by substituting "eight" for "half-past seven," so as to read : —

"9. The annual meeting and the other stated meetings shall be holden at eight o'clock, P. M."

The vacancy occasioned by the death of the President, Joseph Lovering, was filled by the election of

JOSIAH P. COOKE, *President*.

Dr. Peabody, in relinquishing the chair, expressed the pleasure he had experienced while serving as an officer of the Academy, and intimated his intention of declining re-election as Vice-President at the approaching annual meeting.

The President elect addressed the Academy as follows : —

I thank you most warmly for the very great honor you have conferred by this election as your President, and I need not to assure you that I shall work for the best interests of our Academy so long as your favor and my health and strength permit. I have been for nearly forty years a member, and for thirty-eight years I have discharged the duties of one or another of your subordinate offices. For nineteen years I have been your Corresponding Secretary, and during that time have edited twenty volumes of your Proceedings and Memoirs, — much more than one half of all the material published by the Academy since its foundation. You can understand from this what pleasure it will give me to finish this long period of service as your presiding officer. Moreover, my associations with the Academy go back before my membership.

It so happened that my honored father occupied for a long period a law office at No. 9 State Street, adjoining that of John Pickering, that noble man and learned scholar, who was your President from 1839 to 1846. Through the kindness of this great man, who warmly encouraged a boy's scientific tastes, I had free access to his library and the use of his books; and it was there that I came to know that there was such a learned society as the American Academy of Arts and Sciences, and to indulge the thought that I might one day make myself worthy to become a member of such an illustrious body. I cannot but confess that the lustre has become somewhat dimmed with

use; but my colleagues will appreciate how great a privilege I feel it is to fill the place once held by this beloved patron of my youth, and later by Jacob Bigelow, the good physician of my boyhood, and by Asa Gray and by Joseph Lovering, my college teachers and the warm friends of my manhood.

The PRESIDENT in the chair.

Dr. Seth C. Chandler presented a paper entitled, "Results of Researches on Variable Stars." A discussion of this paper followed, and remarks were made by Messrs. Searle, Edmands, and Dolbear.

Dr. Henry Taber presented a paper entitled, "On a Theorem of Sylvester's relating to Degenerate Matrices."

Eight hundred and forty-ninth Meeting.

April 13, 1892. — ADJOURNED STATED MEETING.

The PRESIDENT in the chair.

The President read a letter from Captain Andrew H. Russell, accepting Fellowship in the Academy; also, a circular from the Executive Committee of the Congress of Engineers and Architects at Palermo, inviting members of the Academy to take part in its deliberations.

The vacancies in the Rumford Committee, occasioned by the death of Joseph Lovering and of George B. Clark, were filled by the election of the following

Members of the Rumford Committee:

EDWARD C. PICKERING, CHARLES R. CROSS.

Dr. Seth C. Chandler presented a paper entitled, "Results of Researches on Variations of Latitudes."

Professor Jackson presented, by title, a paper on the Formation of the Anhydrides of Benzoic and substituted Benzoic Acids. By George D. Moore and Daniel F. O'Regan.

Eight hundred and fiftieth Meeting.

May 11, 1892. — SOCIAL MEETING.

The Academy met at the University Museum, Cambridge.

The PRESIDENT in the chair.

The President announced the death of August Wilhelm Hofmann, of Berlin, Foreign Honorary Member of the Academy, and gave a brief sketch of his scientific work.

The following papers were read: —

Biographical Memoir of the late Sereno Watson. By George L. Goodale.

On Bivalent Carbon. By John U. Nef.

Diamonds in Meteoric Iron. By Oliver W. Huntington.

The mineral cabinet of Harvard College was fortunate enough to obtain, through the liberality of Francis Bartlett, Esq., one of the two original masses of meteoric iron, weighing 154 pounds, brought by Dr. A. E. Foote from near Cañon Diablo, Arizona. As this iron had been said to contain diamond, the following experiments were made with a view of isolating if possible the diamondiferous material. A mass of about one hundred grams' weight was dissolved in acid assisted by a battery.

The iron was supported on a perforated platinum cone hung in a platinum bowl filled with acid, and the cone was made the positive pole and the dish the negative pole of a Bunsen cell. When the iron had disappeared, there was left on the cone a large amount of a black slime. This was repeatedly washed and the heavier particles collected. This residue examined under a microscope showed black and white particles, the black particles being mainly soft amorphous carbon, while the composition of the white particles appeared less easy to determine, though when rubbed over a watch-glass certain grains readily scratched the surface.

The material was then digested over a steam bath for many hours with strong hydrofluoric acid, and some of the white particles disappeared, showing them to have been silicious. Most of them, however, resisted the action of the acid. These last were carefully separated by hand, and appeared to the eye like a quantity of fine white beach sand, and under the microscope they were transparent and of a brilliant lustre. A single particle was then mounted in a point of metallic lead, and when drawn across a watch-crystal it gave out the familiar singing noise so characteristic of a glass-cutter's tool, and

with the same result, namely, of actually cutting the glass completely through. To verify the phenomenon, successive particles were used for the purpose, and with the same result. The experiment was then tried on a topaz, and the same little mineral point was found to scratch topaz almost as readily as it did glass. It was finally applied to a polished sapphire, and readily scratched that also, proving beyond question that this residue of small, white, transparent grains must be diamond, though no well formed crystals could be recognized.

Dr. Huntington then exhibited in the hollow of a watch-glass the diamonds which he had obtained from the meteorite.

Catalogue of the Magnitudes of Southern Stars from 0° to -30° declination, to the Magnitude of 7.0 inclusive. By Edwin F. Sawyer.